(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 470 243 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
17.04.2019 Bulletin 2019/16

(21) Application number: **17813321.1**

(22) Date of filing: **13.06.2017**

(51) Int Cl.:
B60C 11/11 ***(2006.01)*** ***B60C 11/03*** ***(2006.01)***
B60C 11/12 ***(2006.01)***

(86) International application number:
PCT/JP2017/021861

(87) International publication number:
WO 2017/217425 (21.12.2017 Gazette 2017/51)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **13.06.2016 JP 2016117229**

(71) Applicant: **Bridgestone Corporation**
Tokyo 104-8340 (JP)

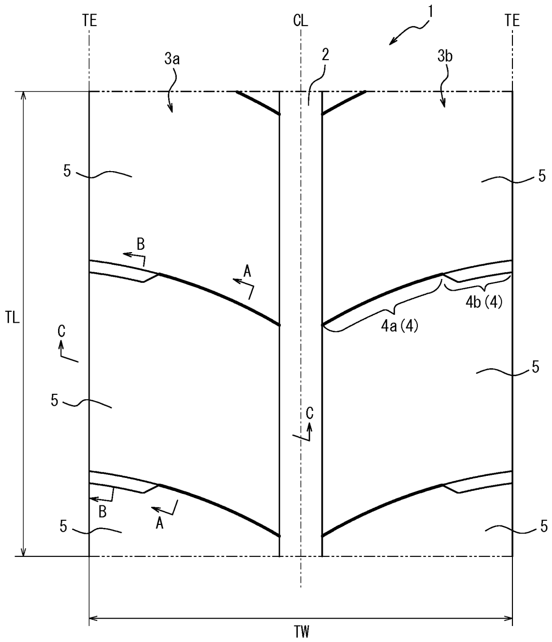
(72) Inventor: **HIRAISHI Tomohiro**
Tokyo 104-8340 (JP)

(74) Representative: **Oxley, Robin John George**
Marks & Clerk LLP
90 Long Acre
London WC2E 9RA (GB)

(54) **TIRE**

(57) Provided is a tire, comprising a tread surface divided into a plurality of land portions by at least one circumferential groove extending along a tire equator and tread edges, wherein at least one of the land portions divided by the at least one circumferential groove and the tread edges comprises a plurality of blocks divided by a plurality of width direction grooves; each of the blocks has a shape that protrudes from four sides toward a central portion; and each of the width direction grooves comprises a sipe portion.

FIG. 1



EP 3 470 243 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to tires, particularly to high performance tires having high drainage performance, braking performance and turning performance.

BACKGROUND

[0002] Conventionally, particularly in the field of high performance tires, it is known to enlarge blocks in order to improve the block rigidity during load rolling. For example, PTL 1 discloses a tire in which blocks are enlarged to improve the block rigidity, and thereby the cornering force (CF) characteristics are improved.

CITATION LIST

Patent Literature

[0003] PTL 1: JPH 10-297216 A

SUMMARY

(Technical Problem)

[0004] When the blocks of a tire tread are enlarged as described above, the block rigidity is improved; however, there is a problem that the grounding property in the blocks deteriorates especially during high speed rolling of the tire. That is, during rolling of the tire, when a load is applied to the tread surface, the force concentrates on the boundaries between the groove bottom and the groove walls of each width direction groove, such that a stress is generated toward the inside of each block from the side walls of the block, causing deformation that the end portions in the width direction of each block are pushed up. As a result, the ground contact pressure at the central portion of each block becomes lower than the surroundings. Particularly, at the time of high speed rotation, the ground contact pressure of the tire tread surface is higher than that at the time of low speed rotation, such that deterioration of the grounding property inside each block becomes remarkable. As described above, the grounding property in each block becomes non-uniform, such that the drainage performance, braking performance and turning performance might have not been sufficiently improved. In other words, the larger the blocks, the greater the difference in ground contact pressure between the central portion and the end portions of each block, such that the problem remains in that the effect of enlarging the blocks cannot be sufficiently enjoyed.

[0005] It is an object of the present disclosure to provide a high performance tire that improves the grounding property of blocks, and thereby further improving the drainage performance, braking performance and turning performance.

(Solution to Problem)

[0006] The inventor conducted a diligent investigation in order to solve the above problem. Through this investigation, the inventor discovered that in order to increase the ground contact pressure at the central portion of a block, it is effective to adopt a shape that protrudes toward the central portion. On the other hand, since the rubber of the protruding portion swells toward the sides of the block at the time of grounding, it was found that a protruding shape is not such useful for increasing the ground contact pressure at the central portion. Then, it was found that by forming a part of each width direction groove like a sipe having a very narrow opening width, the rubber of the protruding portion can be prevented from swelling toward the sides of the block, and the adjacent blocks protrude in a manner supported by each other, enabling an increase in ground contact pressure at the central portion.

That is, the inventor discovered that in order to avoid deterioration in grounding property of a block, it is effective to adopt a shape that protrudes toward the central portion of the block and suppress swelling of the protruding rubber toward width direction grooves by forming a part of each width direction groove to be a sipe, and thereby completed the present disclosure.

[0007] The subject of this disclosure is as follows.

(1) A tire, comprising a tread surface divided into a plurality of land portions by at least one circumferential groove extending along a tire equator and tread edges, wherein at least one of the land portions divided by the at least one circumferential groove and the tread edges comprises a plurality of blocks divided by a plurality of width direction

grooves; each of the blocks has a shape that protrudes from four sides toward a central portion; and each of the width direction grooves comprises a sipe portion.

[0008] Here, a "ground contact width" in the present disclosure refers to the maximum straight line distance in the tread width direction on a contact surface with a flat plate, when the tire is mounted on an applicable rim and placed perpendicularly to the flat plate in a stationary state with the air pressure set to be a prescribed value, and a load corresponding to a prescribed mass is applied thereto. Further, a "ground contact length" refers to the maximum straight line distance in the tread circumferential direction on the same contact surface.

[0009] Furthermore, an "applicable rim" refers to a rim prescribed by an industrial standard which is valid in an area where the tire is manufactured and used, and examples of the industrial standard include: "JATMA (The Japan Automobile Tyre Manufacturers Association, Inc.) YEAR BOOK" of Japan; "STANDARDS MANUAL" of ETRTO (The European Tyre and Rim Technical Organisation) of Europe; and "TRA (THE TIRE AND RIM ASSOCIATION INC.)Year Book" of the United States.

(Advantageous Effect)

[0010] According to the present disclosure, a high performance tire having high drainage performance, braking performance and turning performance can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In the accompanying drawings:

FIG. 1 is a developed view illustrating a tread surface of a tire according to a first embodiment of the present disclosure;
FIG. 2 is a partially enlarged view taken of FIG. 1;
FIGS. 3A is a cross-sectional view taken from line A-A in FIG. 1;
FIGS. 3B is a cross-sectional view taken from line B-B in FIG. 1;
FIGS. 3C is a cross-sectional view taken from line C-C in FIG. 1;
FIG. 4 illustrates another embodiment of A-A section in FIG. 1; and
FIG. 5 is a developed view illustrating a tread surface of a tire according to a second embodiment of the present disclosure.

DETAILED DESCRIPTION

[0012] Hereinafter, a pneumatic tire of the present disclosure (hereinafter also referred to as "the tire") is described in details with reference to the accompanying drawings by exemplifying embodiments thereof.
Although it is omitted in the drawings, a regular tire structure comprising a pair of sidewall portions respectively extending from a pair of bead portions in a radially outward direction; a carcass composed of an organic fiber cord or a steel cord ply extending from one bead portion to the other bead portion through a crown portion including a tread portion formed to extend between the sidewall portions; and a belt composed of a steel cord layer disposed between the carcass and the tread.

[First Embodiment]

[0013] FIG. 1 is a developed view illustrating a tread surface of a tire according to a first embodiment of the present disclosure, and FIG. 2 is a partially enlarged view thereof. In the present tire, a tread surface 1 of the tread (Hereinafter, it is referred to as "the tread surface".) is divided into a plurality of land portions 3a and 3b by at least one circumferential groove extending along a tire equator CL, specifically, a circumferential groove 2 in the illustrated example, and tread edges TE.

[0014] At least one of the land portions 3a and 3b, specifically, both of the land portions 3a and 3b in the illustrated example, are divided into a plurality of blocks 5 by a plurality of width direction grooves 4 communicating with the circumferential groove 2 and the tread edges TE. The circumferential groove 2 and the width direction grooves 4 are provided in the tread to ensure drainage performance.
Here, each width direction groove 4 is constituted by a sipe portion 4a extending from the circumferential groove 2 to a tread edge TE side and a groove portion 4b extending from the sipe portion 4a to the tread edge TE side. A sipe portion is a groove having an extremely narrow width such that it closes in the tread footprint during rolling of the tire, and a groove portion is a groove having a width such that it remains open in the tread footprint.

[0015] Each block 5 has a shape that protrudes from the four sides of the block 5 toward the central portion. Regarding this protruding shape, cross-sectional views taken from line A-A, line B-B and line C-C in FIG. 1 are respectively illustrated in FIGS. 3A, 3B and 3C. As illustrated in these cross-sectional views, the block 5 has a shape that protrudes from the four sides of the block to the central portion conforming to an arc.

[0016] As described above, in the case that the block 5 defined by the circumferential groove 2 and the width direction grooves 4 is a conventional one whose surface is substantially flat, the ground contact pressure at the end portions of the block is higher than that at the central portion. On the contrary, according to the present disclosure, since the ground contact pressure of the central portion when the block grounds can be increased by adopting a shape that protrudes from the four sides of the block toward the central portion, the ground contact pressure difference between the central portion and the end portions becomes extremely small. Here, during rolling of the tire, if the rubber of the central portion which preferentially contacts the road surface swells and deforms toward the width direction groove sides of the block, it becomes difficult to enjoy the effect of increase in ground contact pressure due to the aforementioned protrusion of the central portion, and therefore it is essential to provide a sipe portion 4a in each width direction groove 4. Provided with the sipe portion 4a, swelling deformation of the block rubber toward the width direction groove 4 sides is suppressed, and therefore an increase in ground contact pressure due to the protrusion of the block central portion is realized.

[0017] As illustrated in FIGS. 3A, 3B and 3C, the block 5 has a shape that protrudes from the four sides which are respectively in contact with the circumferential groove 2, the tread edge TE and the width direction grooves 4 defining the block 5 to an apex 6, conforming to an arc shape in the illustrated example. By forming the block 5 into such a shape to protrude toward the apex 6 in the form of, for example, an arc, it is possible to increase the ground contact pressure of the central portion when the block grounds, and thereby suppressing the ground contact pressure difference between the central portion and the end portions. Additionally, such a protruding shape also contributes to make it easier for moisture in the ground contact region of the tread to be discharged toward the circumferential groove 2, the tread edges TE, and the width direction grooves 4 when grounding on a road surface. Further, in the FIGS. 3A, 3B and 3C, the apex 6 is the apex of the protrusion; however, as illustrated in FIG. 4, it may have a certain area spreading at the same height.

[0018] Here, each width direction groove 4 includes a sipe portion 4a. The sipe portion 4a may be disposed at a tire tread edge side, or at the central portion of the width direction groove 4; however, is preferably disposed at the tire equator side. Since the ground contact pressure distribution on the tread surface during straight running becomes higher at the central portion than at the tread edges, by suppressing swelling deformation of the block portion at the tire equator side having a higher ground contact pressure in the block, equalization of the ground contact pressure distribution of the entire block 5 can be reliably achieved.

[0019] In the present disclosure, as illustrated in FIG. 2, it is preferable that the sipe portion 4a has a longitudinal direction (the sipe extension direction) length d1 that is 30% to 90% of the total longitudinal direction length D of the width direction groove 4. This is because, by setting it to be 30% or more, swelling deformation of the block rubber toward the width direction groove when the central portion of the block 5 grounds on a road surface is sufficiently suppressed. Preferably, 55% to 65% is effective for realizing better suppression effect of swelling deformation of the block 5. On the other hand, by setting it to be 90% or less, swelling deformation of the block rubber toward the width direction groove 4 side is suppressed without causing deterioration in drainage performance.

[0020] In the present disclosure, it is preferable that the sipe portion 4a of the width direction groove 4 has an opening width of 0.05 mm to 0.5 mm. By defining the opening width of the sipe portion 4a as described above, it is possible to more effectively suppress swelling deformation of the block 5 toward the side surface, and suppress the grounding property difference between the end portions and the central portion of the block 5. Further, it is possible to minimize reduction in rigidity due to formation of the width direction groove 4.

The opening width of the sipe portion 4a is more preferably 0.05 mm to 0.4 mm, and further preferably 0.05 mm to 0.3 mm. With such a configuration, it is possible to prevent reduction in rigidity of the block 5, while more effectively equalizing the ground contact pressure distribution of the block. Further, in order to ensure sufficient drainage performance by the width direction groove 4, it is preferable that the groove portion 4b has an opening width of 0.1 mm to 0.5 mm.

[0021] In the present disclosure, as illustrated in FIG. 2, in the planar view, it is preferable that the apex 6 has an area (area "a") that is 1/4 or less of the total area A of the block 5. Thereby, equalization of the ground contact pressure due to provision of the apex 6 can be realized more effectively. It is more preferably 1/6 or less, and further preferably 1/9 or less.

[0022] Also, it is preferable that, the apex 6 has a tread width direction maximum length w1 that is 30% to 40% of the width direction length W of the block; and the apex 6 has a tread circumferential direction maximum length 11 that is 30% to 40% of the circumferential direction length L of the block. With such a configuration, it is possible to suppress decrease in footprint area of the block even if the load applied to the tread surface is relatively low.

[0023] In the protrusion of the block, it is preferable that the apex 6 is located within the overlapping region between the intermediate portion when the width direction length W of the block 5 is equally divided into three and the intermediate portion when the circumferential direction length L of the block 5 is equally divided into three. With such a configuration, the ground contact pressure distribution of the block 5 can be further equalized. In the case that the block 5 is not rectangular, it is preferable that the overlapping region has a shape along the sides constituting the block 5 and substantially similar to the block 5. Further, as illustrated in FIG. 2, it is possible to provide a notch parallel to the end portion of the groove portion 4b of the width direction groove 4. The same applies to the shape of the apex 6.

[0024] It is preferable that the presently disclosed block 5 protrudes from the opening edge 40 of each width direction groove 4 and the opening edge 20 of the circumferential groove 2 toward the central portion. In FIGS. 3A, 3B and 3C, the radial direction height from the opening edge 40 of the width direction groove 4 to the apex 6 and the radial direction height from the opening edge 20 of the circumferential groove 2 to the apex 6 are indicated as h.

[0025] Regarding the protrusion of the block, it is preferable that the block 5 has a tire radial direction height h up to the apex 6 and a width direction length W that satisfy the following equation:

$$0.01 \leq h/W \leq 0.023.$$

When h/W is less than the lower limit, the grounding property cannot be improved. On the other hand, when h/W exceeds the upper limit, the footprint area decreases.

[0026] Further, regarding the protrusion of the block, it is preferable that the tire radial direction height h from the opening edge 40 of the width direction groove 4 to the apex 6 is 0.5 mm to 1.5 mm. This is because, by providing a sufficient height difference between the end portions and the central portion of the block, it becomes easy for the rubber at the central portion to preferentially contact the road surface during rolling of the tire. When it is 0.5 mm or more, equalization of the ground contact pressure distribution can be achieved; however, when it exceeds 1.5 mm, the footprint area decreases, which may result in deterioration in grounding property. It is more preferably 0.8 mm to 1.0 mm. Thereby, the ground contact pressure can be further equalized.

[0027] It is preferable that the width direction length W of the block 5 is 28% to 70% with respect to the ground contact width TW of the tire. With such a configuration, it is possible to ensure block rigidity that is enough to compete with side forces during high speed turning, which leads to improvement in movement performance.

It is more preferably 33% to 42%, and further preferably 36% to 40%. By setting this numerical range, it is possible to equalize the ground contact pressure distribution at a high level while maintaining sufficient block rigidity.

[0028] It is preferable that the circumferential direction length L of the block 5 is 35% to 49% with respect to the ground contact length TL of the tire. That is, during acceleration and deceleration of the vehicle, an input acting in the circumferential direction is generated in the tire; however, by having such a configuration, it is possible to ensure block rigidity that is enough to compete with such an input and improve the movement performance.

It is more preferably 38% to 46%, and further preferably 41% to 44%. By setting this numerical range, it is possible to equalize the ground contact pressure distribution at a high level while maintaining sufficient block rigidity.

[Second Embodiment]

[0029] Next, a tire according to a second embodiment of the present disclosure is described with reference to FIG. 5. FIG. 5 is a developed view illustrating the tread surface of the tire according to the second embodiment of the present disclosure. Components in FIG. 5 that are similar to those in FIG. 1 are given the same reference signs as in FIG. 1 and the description thereof is omitted. As illustrated in FIG. 5, in this tire, the tread surface 1 is divided into three land portions by two circumferential grooves 7a and 7b extending along the tire equator CL and the tread edges TE. In the illustrated example, a central land portion 8 defined by the circumferential grooves 7a and 7b, and shoulder land portions 9a and 9b respectively defined by the circumferential groove 7a and a tread edge TE and by the circumferential groove 7b and the other tread edge TE are formed.

[0030] The shoulder land portions 9a and 9b are divided into a plurality of blocks 12 by a plurality of width direction grooves 10. The width direction grooves 10 and the blocks 12 have the same configuration as that of the width direction grooves 4 and the blocks 5 in FIG. 1. By disposing land portions having such a configuration at the tread edges sides of the tire, higher turning performance can be ensured. That is, since the ground contact pressure distribution in the tread width direction of the tire during turning becomes higher in the areas adjacent to the tread edges than the central portion, by equalizing the ground contact pressure distribution in the areas adjacent to the tread edges, the turning performance can be improved. Further, moisture in the ground contact region of the tread can be easily discharged when grounding on a road surface.

[0031] On the other hand, the central land portion 8, as illustrated, is divided into a plurality of blocks 13 by a plurality of sipes 11 extending in the tread width direction.

[0032] Like the blocks 5 in the first embodiment, the blocks 13 preferably have a shape that protrudes toward the central portion. Thereby, even in the vicinity of the tire equator, the ground contact pressure distribution of each block can be equalized, and the drainage performance can be improved. Further, during rolling of the tire, if the rubber of each central portion which preferentially contacts the road surface swells and deforms, it becomes difficult to enjoy the effect of increase in ground contact pressure due to protrusion of the central portions. Therefore, by dividing the blocks 13 by the sipes 11, swelling deformation of the block rubbers toward the sipe 11 sides is suppressed, and as a result, an increase in ground contact pressure due to protrusion of the central portion of each block is realized.

[0033] As illustrated, each sipe 11 has a certain opening width, and similarly to the width direction grooves 4 in FIG. 1, may be constituted by a sipe portion and a groove portion. By setting a part thereof to have an opening width that is substantially the same as that of the groove portion 4b of each width direction groove 4, better drainage performance can be ensured.

[0034] Here, since the central land portion 8 is divided into a plurality of blocks 13 by a plurality of sipes 11, and the blocks 13 have a protruding shape, it is possible to increase the ground contact pressure at the central portions and improve the drainage performance when the blocks 13 ground.

[0035] Additionally, the sipe portion 10a and groove portion 10b of each width direction groove 10 may have chamfers 10c and 10d applied to the opening edges, and each sipe 11 may have chamfers 11c and 11d applied to the opening edges. With such a configuration, the drainage performance can be improved.

EXAMPLES

[0036] The following describes Examples of the disclosure; however, the disclosure is in no way limited thereto.

[0037] Tires of size 205/55R16 according to the tread patterns illustrated in FIG. 1 and FIG. 5 were respectively trial-manufactured under the conditions listed in Table 1. Note that the depths of each circumferential direction groove, width direction groove and sipe are 4 mm for all Sample Tires.

[0038] After attaching each obtained Sample Tire to a rim (having a size of 7.0 J) with an internal pressure of 240 kPa, it was assembled to a rear wheel drive vehicle of 2000 cc displacement, and thereafter, the drainage performance, braking performance and turning performance were evaluated when the vehicle runs on a test course (dry road surface and wet road surface included) with a driver riding.

[Turning Performance] [Braking Performance]

[0039] For each of the above tires, the turning performance and braking performance when running on a dry road surface were evaluated by sensory evaluation by the driver. The results were indicated as a relative value taking the evaluation results of Sample Tire 1 as 100. Note that the larger the value, the better the performance.

[Drainage Performance]

[0040] For each of the above tires, the running performance during running on a wet road surface (having a water depth of 1 mm) was evaluated by sensory evaluation by the driver. The result was evaluated as a relative value taking the evaluation result of Sample Tire 1 as 100. Note that the larger the value, the better the drainage performance.

[Table 1-1]

	Sample Tire 1	Sample Tire 2	Sample Tire 3	Sample Tire 4	Sample Tire 5	Sample Tire 6	Sample Tire 7	Sample Tire 8	Sample Tire 9	Sample Tire 10	Sample Tire 11	Sample Tire 12
Width direction groove	None	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sipe portion	-	None	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Protrusion of block	-	None	None	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Position of sipe portion	-	-	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side
Longitudinal direction length d1 of sipe portion 4a / longitudinal direction length D of width direction groove 4	-	-	65%	50%	65%	65%	65%	65%	65%	65%	65%	65%
Opening width of sipe portion 4a	-	-	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm
Area a of apex / area A of block	-	-	-	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1/9
Width direction length w1 of apex / width direction length W of block	-	-	-	30%	30%	30%	30%	30%	30%	30%	30%	30%

(continued)

	Sample Tire 1	Sample Tire 2	Sample Tire 3	Sample Tire 4	Sample Tire 5	Sample Tire 6	Sample Tire 7	Sample Tire 8	Sample Tire 9	Sample Tire 10	Sample Tire 11	Sample Tire 12
Circumferential direction length l1 of apex / circumferential direction length L of block	-	-	-	30%	30%	30%	30%	30%	30%	30%	30%	30%
Position of apex of protrusion (trisection)	-	-	-	Intermidiate portion	Intermidiate portion	End portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion
Radial height h of apex	-	-	-	1.0 mm	1.0 mm	1.0 mm	0.47 mm	1.3 mm	0.30 mm	1.6 mm	0.6 mm	1.1 mm
Radial height h of apex / width direction length W of block	-	-	-	0.020	0.020	0.020	0.009	0.026	0.006	0.032	0.012	0.022
Width direction length W of block / ground contact width TW of tire	-	-	40%	32%	40%	40%	40%	40%	40%	40%	40%	40%
Circumferential direction length L of block / ground contact length TL of tire	-	-	44%	40%	44%	44%	44%	44%	44%	44%	44%	44%
Width direction length W of block	-	-	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm

(continued)

	Sample Tire 1	Sample Tire 2	Sample Tire 3	Sample Tire 4	Sample Tire 5	Sample Tire 6	Sample Tire 7	Sample Tire 8	Sample Tire 9	Sample Tire 10	Sample Tire 11	Sample Tire 12
Circumferential direction length L of block	-	-	50 mm	60mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm
Drainage performance	100	120	125	141	140	120	133	145	128	148	135	142
Braking performance	100	98	99	107	110	101	104	104	103	101.5	108	106
Turning performance	100	98	99	108	110	101	107.5	105	103	101.5	108.5	107.5
Remarks	Comparative Example	Comparative Example	Comparative Example	Example	Example	Example	Example	Example	Example	Example	Example	Example

[Table 1-2]

	Width direction groove	Sipe portion	Protrusion of block	Position of sipe portion	Longitudinal direction length d1 of sipe portion 4a / longitudinal direction length D of width direction groove 4	Opening width of sipe portion 4a	Area a of apex / area A of block	Width direction length w1 of apex / width direction length W of block
Sample Tire 13	Yes	Yes	Yes	Tire equator side	65%	0.3 mm	1/3	30%
Sample Tire 14	Yes	Yes	Yes	Tire equator side	65%	0.3 mm	1/4	30%
Sample Tire 15	Yes	Yes	Yes	Tire equator side	65%	0.3 mm	1/6	30%
Sample Tire 16	Yes	Yes	Yes	Tie equator side	65%	0.3 mm	1/9	20%
Sample Tire 17	Yes	Yes	Yes	Tire equator side	65%	0.3 mm	1/9	50%
Sample Tire 18	Yes	Yes	Yes	Tire equator side	65%	0.3 mm	1/9	40%
Sample Tire 19	Yes	Yes	Yes	Tire end side	65%	0.3 mm	1/9	30%
Sample Tire 20	Yes	Yes	Yes	Width direction groove center	65%	0.3 mm	1/9	30%
Sample Tire 21	Yes	Yes	Yes	Tire equator side	20%	0.3 mm	1/9	30%
Sample Tire 22	Yes	Yes	Yes	Tire equator side	95%	0.3 mm	1/9	30%
Sample Tire 23	Yes	Yes	Yes	Tire equator side	30%	0.3 mm	1/9	30%
Sample Tire 24	Yes	Yes	Yes	Tire equator side	90%	0.3 mm	1/9	30%

(continued)

	Sample Tire 13	Sample Tire 14	Sample Tire 15	Sample Tire 16	Sample Tire 17	Sample Tire 18	Sample Tire 19	Sample Tire 20	Sample Tire 21	Sample Tire 22	Sample Tire 23	Sample Tire 24
Circumferential direction length l1 of apex / circumferential direction length L of block	30%	30%	30%	20%	50%	40%	30%	30%	30%	30%	30%	30%
Position of apex of protrusion (trisection)	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion	Intermidiate portion
Radial height h of apex	1.0mm	1.0mm	1.0 mm	1.0mm	1.0 mm	1.0mm	1.0 mm	1.0 mm	1.0 mm	1.0mm	1.0 mm	1.0 mm
Radial height h of apex / width direction length W of block	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Width direction length W of block / ground contact width TW of tire	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Circumferential direction length L of block / ground contact length TL of tire	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%
Width direction length W of block	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm

(continued)

	Sample Tire 13	Sample Tire 14	Sample Tire 15	Sample Tire 16	Sample Tire 17	Sample Tire 18	Sample Tire 19	Sample Tire 20	Sample Tire 21	Sample Tire 22	Sample Tire 23	Sample Tire 24
Circumferential direction length L of block	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm
Drainage performance	128	133	136	141	138	140	125	130	145	120	144	136
Braking performance	104.5	104.5	105	106	105	108	110	110	103	112	105	111
Turning performance	103	106.5	107.5	107.5	108	109	110	110	103	112	107	111
Remarks	Example	Example	Example	Example	Example	Example	Example	Example	Example	Example	Example	Example

[Table 1-3]

	Sample Tire 25	Sample Tire 26	Sample Tire 27	Sample Tire 28	Sample Tire 29	Sample Tire 30	Sample Tire 31	Sample Tire 32	Sample Tire 33	Sample Tire 34	Sample Tire 35	Sample Tire 36	Sample Tire 37
Width direction groove	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sipe portion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Protrusion of block	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Position of Sipe portion	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side	Tire equator side
Longitudinal direction length d1 of sipe portion 4a / longitudinal direction length D of width direction groove 4	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Opening width of sipe portion 4a	1.0 mm	0.6 mm	0.5 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm
Area a of apex / area A of block	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1/9
Width direction length w1 of apex / width direction length W of block	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%

(continued)

	Sample Tire 25	Sample Tire 26	Sample Tire 27	Sample Tire 28	Sample Tire 29	Sample Tire 30	Sample Tire 31	Sample Tire 32	Sample Tire 33	Sample Tire 34	Sample Tire 35	Sample Tire 36	Sample Tire 37
Cicumferential direction length l1 of apex / circumferential direction length L of block	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Position of apex of protrusion (trisection)	Intermediate portion	Intermediate portion	Intermediate portion	Intermediate portion	Intermediate portion	Intermediate portion	Intermediate portion	Intermediate portion	Intermediate portion	Intermediate portion	Intermediate portion	Intermediate portion	Intermediate portion
Radial height h of apex	1.0 mm	1.0 mm	1.0mm	1.0 mm	1.0 mm	1.0 mm	1.0 mm	1.0 mm	1.0 mm	1.0 mm	1.0 mm	1.0 mm	1.0 mm
Radial height h of apex / width direction length W of block	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.029	0.020
Width direction length W of block / ground contact width TW of tire	40%	40%	40%	27%	71%	35%	65%	40%	40%	40%	40%	40%	40%
Circumferential direction length L of block / ground contact length TL of tire	44%	44%	44%	44%	44%	44%	44%	34%	50%	40%	45%	44%	44%

(continued)

	Sample Tire 25	Sample Tire 26	Sample Tire 27	Sample Tire 28	Sample Tire 29	Sample Tire 30	Sample Tire 31	Sample Tire 32	Sample Tire 33	Sample Tire 34	Sample Tire 35	Sample Tire 36	Sample Tire 37
Width direction length W of block	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	34 mm	49 mm
Circumferential direction length L of block	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	30 mm	45 mm
Drainage performance	141	140	140	140	120	140	137	140	135	140	139	142	141
Braking performance	103.5	103.5	107	108	110	108	111	103.5	105	107	110	103.5	109
Turning performance	105.5	105.5	108.5	106	112	108.5	111	107	107	107.5	109	106	109
Remarks	Example	Example	Example	Example	Example	Example	Example	Example	Example	Example	Example	Example	Example

[0041] As can be seen from Table 1, the tires according to Examples are all better in drainage performance, braking performance and turning performance than those of Sample Tire 1.
Therefore, Examples of the present disclosure is capable of providing a tire with equalized ground contact pressure distribution and improved drainage performance, braking performance and turning performance.

REFERENCE SIGNS LIST

[0042]

1	Tread surface
2	Circumferential groove
20	Edge of circumferential groove 2
3a, 3b	Land portion
4	Width direction groove
4a	Sipe portion
4b	Groove portion
40	Edge of width direction groove 4
5	Block
6	Apex
7a, 7b	Circumferential groove
8	Central land portion
9a, 9b	Shoulder land portion
10	Width direction groove
10a	Sipe portion
10b	Groove portion
10c, 10d	Chamfer
11	Sipe
11c, 11d	Chamfer
12, 13	Block
CL	Tire equator
TE	Tread edge

Claims

1. A tire, comprising
a tread surface divided into a plurality of land portions by at least one circumferential groove extending along a tire equator and tread edges, wherein
at least one of the land portions divided by the at least one circumferential groove and the tread edges comprises a plurality of blocks divided by a plurality of width direction grooves;
each of the blocks has a shape that protrudes from four sides toward a central portion; and
each of the width direction grooves comprises a sipe portion.

2. The tire according to claim 1, wherein
the sipe portion is located at a tire equator side.

3. The tire according to claim 1 or 2, wherein
the sipe portion has a longitudinal direction length that is 30 to 90% of a longitudinal direction length of the width direction groove.

4. The tire according to any one of claims 1 to 3, wherein
the sipe portion has an opening width of 0.5 mm or less.

5. The tire according to any one of claims 1 to 4, wherein
each of the blocks comprises a protrusion with an apex having an area that is 1/4 or less of an area of the block.

6. The tire according to any one of claims 1 to 5, wherein
each of the blocks comprises a protrusion with an apex having a tread width direction maximum length that is 30%

to 40% of a tread width direction length of the block; and
the apex has a tread circumferential direction maximum length that is 30% to 40% of a tread circumferential direction length of the block.

7. The tire according to any one of claims 1 to 6, wherein
each of the blocks comprises a protrusion with an apex being located at an overlapping region between an intermediate portion when the blocks are each equally divided into three in a tread width direction and an intermediate portion when the blocks are each equally divided into three in a tread circumferential direction.

8. The tire according to any one of claims 1 to 7, wherein
a tire radial height from an opening edge of each of the width direction grooves to the apex is 0.01 or more and 0.023 or less with respect to a width direction length of each of the blocks.

9. The tire according to any one of claims 1 to 8, wherein
a tire radial height from an opening edge of each of the width direction grooves to the apex is 0.5 mm to 1.5 mm.

10. The tire according to any one of claims 1 to 9, wherein
each of the blocks has a tread width direction length that is 28% to 70% of a tire ground contact width.

11. The tire according to any one of claims 1 to 10, wherein
each of the blocks has a tread circumferential direction length that is 35% to 49% of a tire ground contact length.

12. The tire according to any one of claims 1 to 11, wherein
each of the blocks has a tread width direction length and a tread circumferential direction length that are both 35 mm or more.

FIG. 1

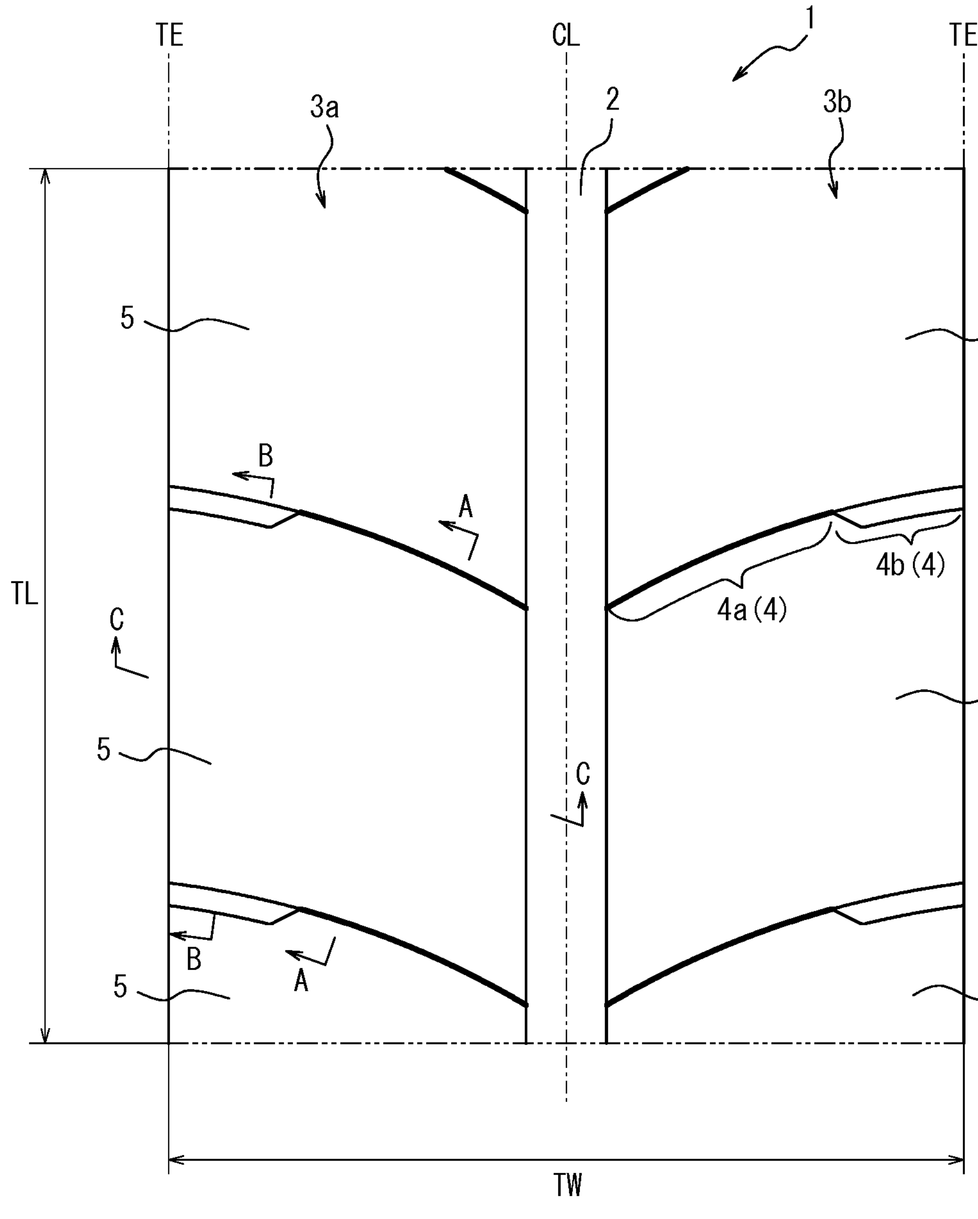


FIG. 2

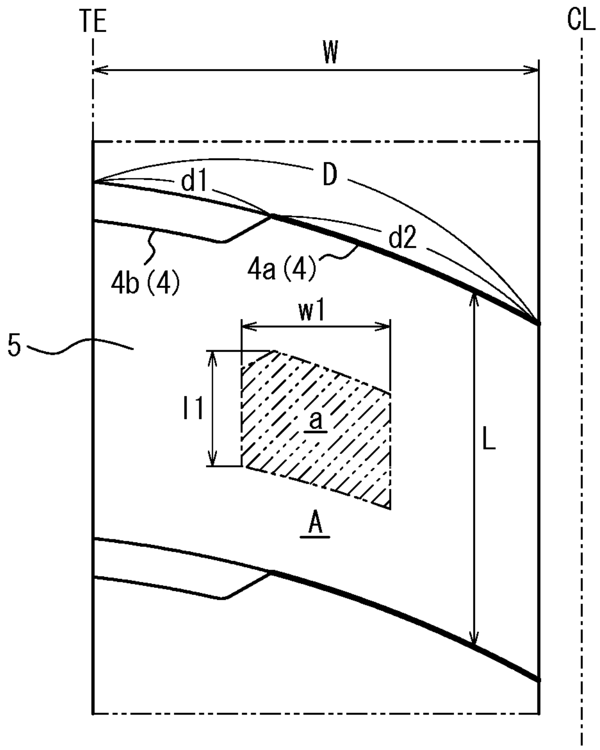


FIG. 3A

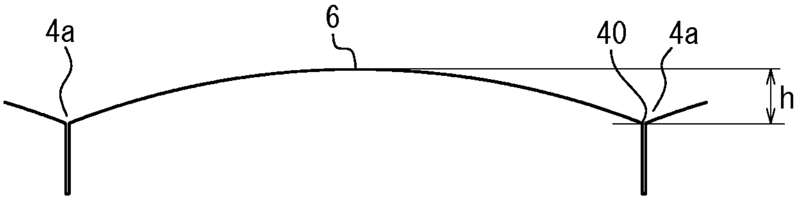


FIG. 3B

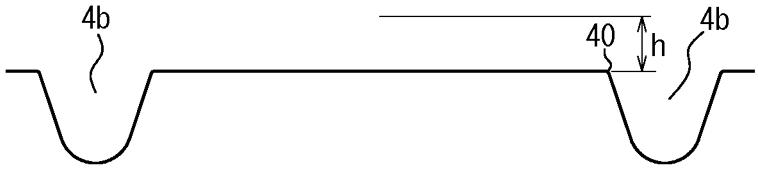


FIG. 3C

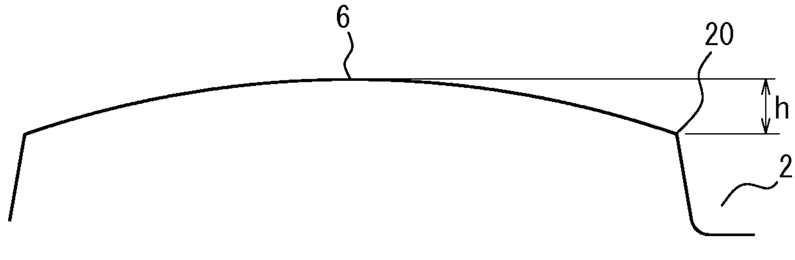


FIG. 4

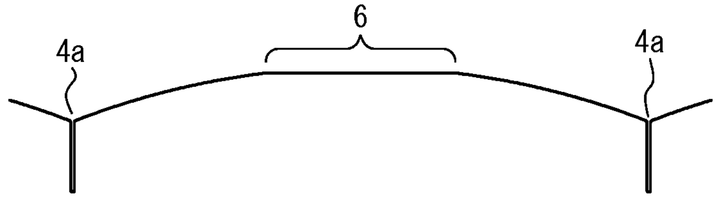
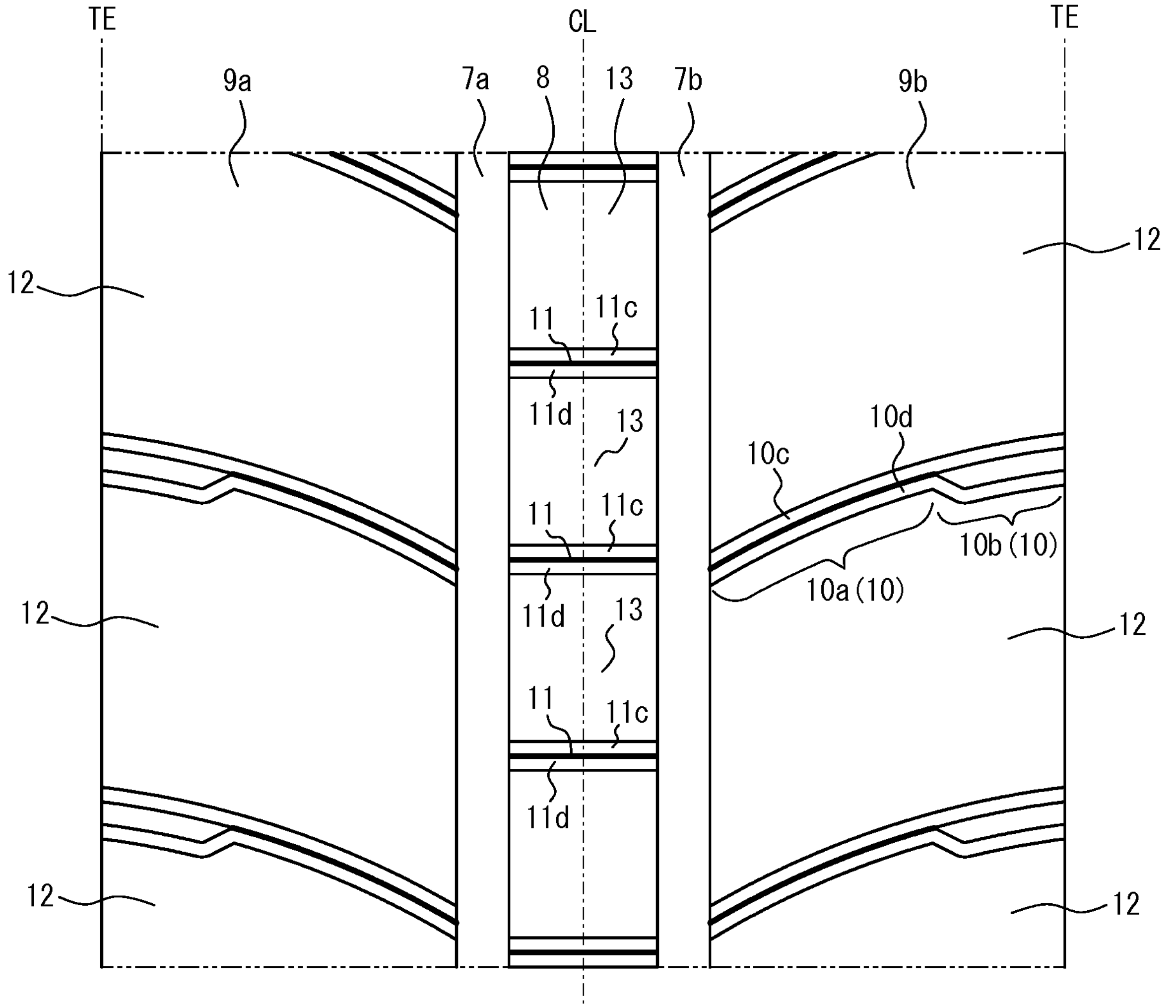

6
4a
4a

FIG. 5


TE
CL
TE
9a
7a
8
13
7b
9b
12
12
11
11c
11d
13
10d
10c
11
11c
10b (10)
11d
10a (10)
12
13
12
11
11c
11d
12
12

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/021861

A. CLASSIFICATION OF SUBJECT MATTER
B60C11/11(2006.01)i, *B60C11/03*(2006.01)i, *B60C11/12*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60C11/11, B60C11/03, B60C11/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Japio-GPG/FX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 2014/148260 A1 (Bridgestone Corp.), 25 September 2014 (25.09.2014), claims; paragraphs [0006], [0018] to [0019], [0022]; drawings & US 2016/0009143 A1 claims; paragraphs [0006], [0031] to [0032], [0035]; figures & EP 2977230 A1 & CN 105142932 A	1-5,7-12 6
Y	WO 2015/016005 A1 (Sumitomo Rubber Industries, Ltd.), 05 February 2015 (05.02.2015), paragraphs [0059] to [0063]; fig. 2, 4 & US 2016/0167443 A1 paragraphs [0057] to [0067]; fig. 2, 4 & EP 3028878 A1 & CN 105377588 A	1-5,7-12

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 August 2017 (21.08.17)	05 September 2017 (05.09.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/021861

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2015/052966 A1 (Bridgestone Corp.), 16 April 2015 (16.04.2015), claims; drawings & US 2016/0236519 A1 claims; figures & EP 3056355 A1 & CN 105705344 A	1-12
A	WO 2004/011282 A1 (Bridgestone Corp.), 05 February 2004 (05.02.2004), claims; drawings & US 2006/0108039 A1 claims; figures & EP 1547820 A1 & CN 1671565 A	1-12
A	WO 02/102611 A1 (Bridgestone Corp.), 27 December 2002 (27.12.2002), claims; drawings & US 2005/0072505 A1 claims; figures & EP 1386758 A1 & CN 1462244 A	1-12

Form PCT/ISA/210 (continuation of second sheet) (January 2015)